

## *Pityrogramma opalescens* (Pteridaceae), a New Species from Cerro del Torrá, Colombia

MICHAEL A. SUNDUE

The New York Botanical Garden, 200<sup>th</sup> St. and Southern Blvd., Bronx, NY 10458-5126

ABSTRACT.—A new species, *Pityrogramma opalescens*, is described; it is known only from Cerro del Torrá, an isolated mountain peak in the Cordillera Occidental of Colombia, which is a region of high diversity and endemism. It is most similar to *Pityrogramma lehmannii*, and the two species differ from all other *Pityrogramma* species by having creeping rhizomes, rhizome scales with turgid cells, an elongate, proximally 1-pinnate lamina, with sessile segments supplied by multiple veins that emerge from the rachis rather than from a single main vein, and farina on the abaxial side of the lamina that is borne at the apex of short hairs. It differs from *P. lehmannii* by more numerous segments that are narrower (3.5–4.0 mm wide vs. 10.0–17.0 mm wide), with more acutely rounded apices, and dull-yellow rather than white farina abaxially.

KEY WORDS.—Taenitidoid, *Pityrogramma lehmannii*, Cerro del Torrá, Colombia

While identifying specimens of Andean ferns, a new species was encountered that had been collected in the Cordillera Occidental of Colombia. It appears most similar to *Pityrogramma lehmannii* (Hieron.) R. M. Tryon, an infrequently collected species known from northern Ecuador and Colombia.

*Pityrogramma* is a primarily neotropical genus of Pteridaceae naturalized in many tropical regions of the Old World (Tryon *et al.*, 1990). It was most recently revised by Tryon (1962) who recognized 14 species; however, subsequent authors have considered it slightly larger, with Tryon and Tryon (1982) recognizing 16 species, and Mickel and Smith (2004) recognizing 17 species. Domin (1928, 1929, 1941) made critical early taxonomic contributions, but his 1929 monograph inflated the number of infra-specific taxa and confounded the nomenclature by typifying names on incomplete specimens of cultivated material that lack precise locality data.

Tryon *et al.* (1990) treated *Pityrogramma* as part of Pteridaceae subfam. Taenitidoideae (the “taenitids”), a group of about 15 genera defined by having exindusiate sporangia spread along the veins and spores with a prominent equatorial flange. *Pityrogramma* is distinguished from other taenitid genera by having rhizomes that bear scales and not bristles, laminae that are usually 2–4-pinnate and often abaxially farinose, and spores with 1–4 accessory ridges parallel to the equatorial flange and coarse markings on the distal face (Tryon *et al.*, 1990; Yatskievych *et al.*, 1990).

---

The Pringle Herbarium, University of Vermont, Dept. of Plant Biology, 27 Colchester Ave., Burlington, VT 05405. sundue@gmail.com. [current address]

Although not all genera have been sampled, Taenitidoideae have been found to be monophyletic, with the inclusion of *Cosentinia* (Nakazato and Gastony, 2003; Sánchez-Baracaldo, 2004a; Prado *et al.*, 2007; Schuettpelz *et al.*, 2007), which had previously been placed among cheilanthoid ferns by Tryon *et al.* (1990) and Zimmer (1991), or affiliated with other primarily neotropical taenitids by Pichi Sermolli (1985) in his Hemionitidaceae. Several genera of the Taenitidoideae by comparison, including *Anogramma*, *Eriosorus*, and *Jamesonia*, have been revealed to have problems in their circumscription (Nakazato and Gastony, 2003; Sánchez-Baracaldo, 2004a, 2004b; Prado *et al.*, 2007; Schuettpelz *et al.*, 2006). Nakazato and Gastony (2003) demonstrated the polyphyly of *Anogramma* sensu Tryon (1962), and commented that studies with a broader sampling of *Pityrogramma* were necessary to determine whether species unrelated to *Anogramma* s.s. should be considered congeneric with *Pityrogramma* or treated as a coordinate independent genus. This close relation of some *Anogramma* species to *Pityrogramma* was anticipated (Domin, 1929b; Tryon, 1962; Tryon and Tryon, 1982). Nonetheless, *Pityrogramma* sensu Tryon *et al.* (1990) has been recovered as monophyletic in each of these phylogenetic studies, although sampling has been limited.

***Pityrogramma opalescens* Sundue *sp. nov.* TYPE.**—COLOMBIA, Depto. Chocó, Municipio San José del Palmar, Cerro del Torrá, 4°46'N, 76°29'W, abajo del helipuerto en un antiguo alug, y a la orilla del bosque, vereda de Río Negro, 1700 m, 25 Aug 1988, J. E. Ramos, P. A. Silverstone, L. H. Ramos 1523 (Holotype: CUVC-n.v., Isotypes: COL-n.v., NY!; photos of CUVC and COL at NY). **Figs. 1–3.**

Ex affinitate *P. lehmannii* Hieron., sed laminis cum pluribus ((30)60–70) segmentis (vs. cum paucioribus (20–25) segmentis in *P. lehmannii*), segmentis

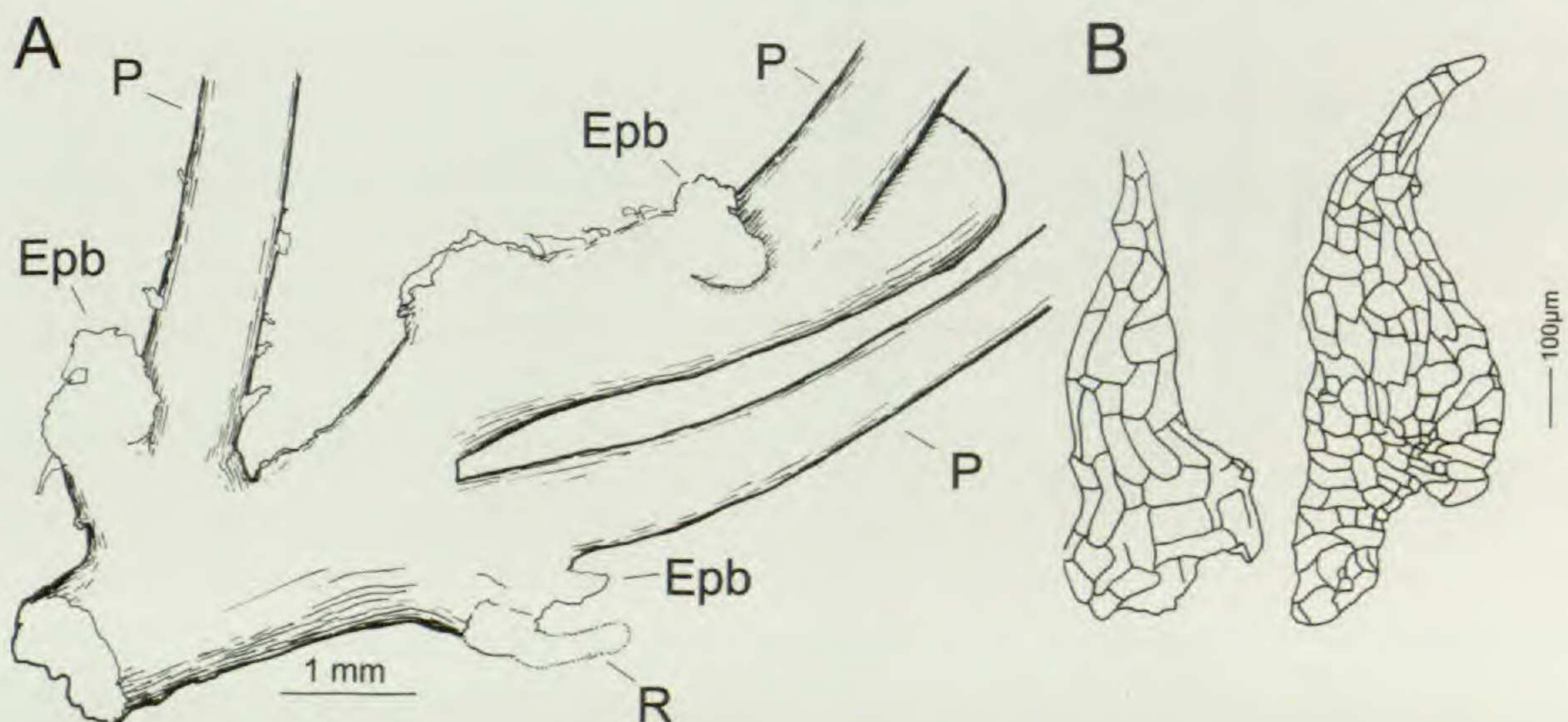


FIG. 1. *Pityrogramma opalescens* (based on the isotype, NY). A. Rhizome depicting position of epipetiolar branch buds, Epb – epipetiolar branch bud, P – petiole, R – root. B. detail of rhizome scales.

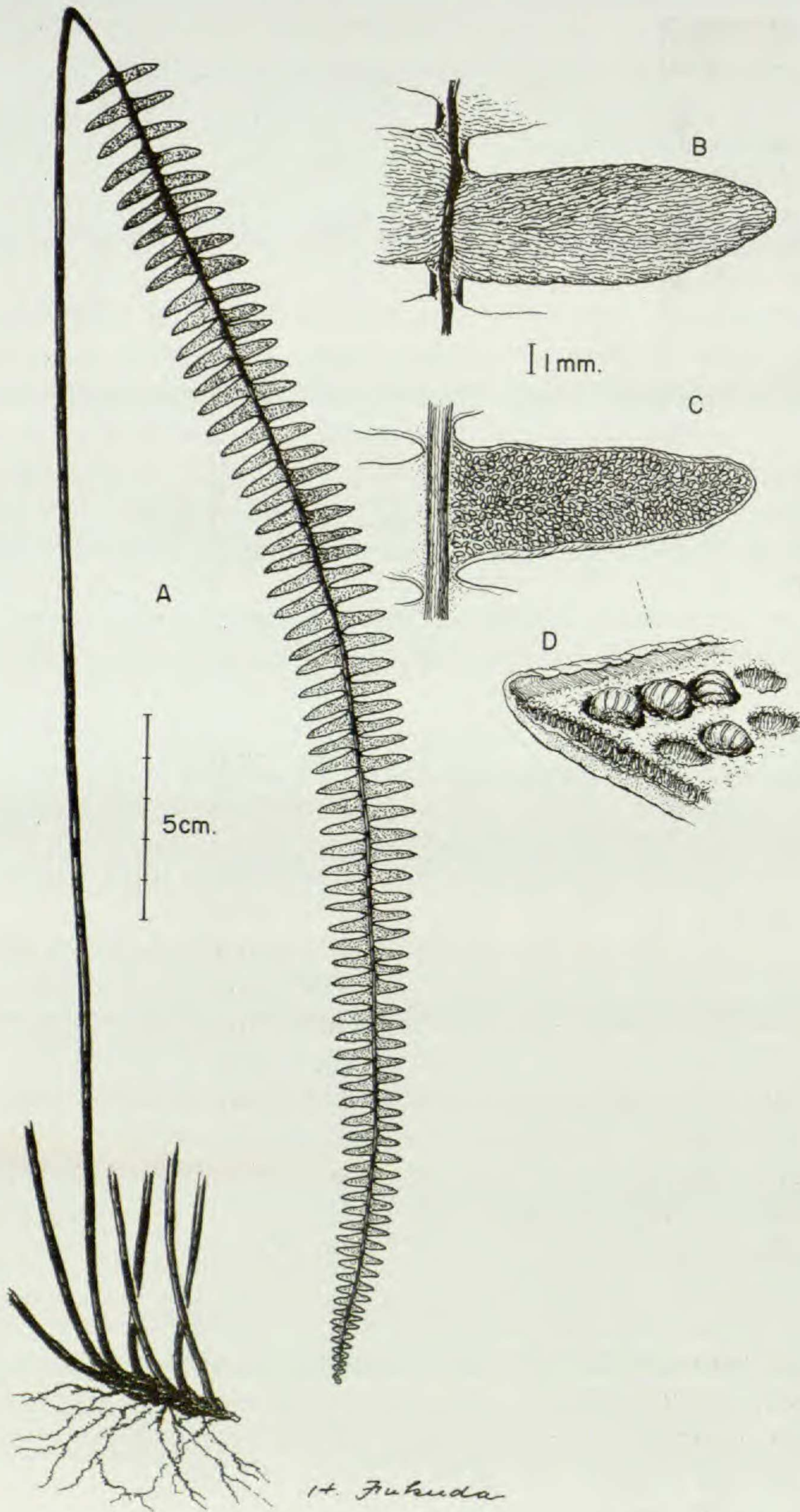


FIG. 2. *Pityrogramma opalescens* (based on the isotype, NY). A. habit. B. adaxial pinna. C. abaxial pinna. D. detail of sporangia and farinose indument.

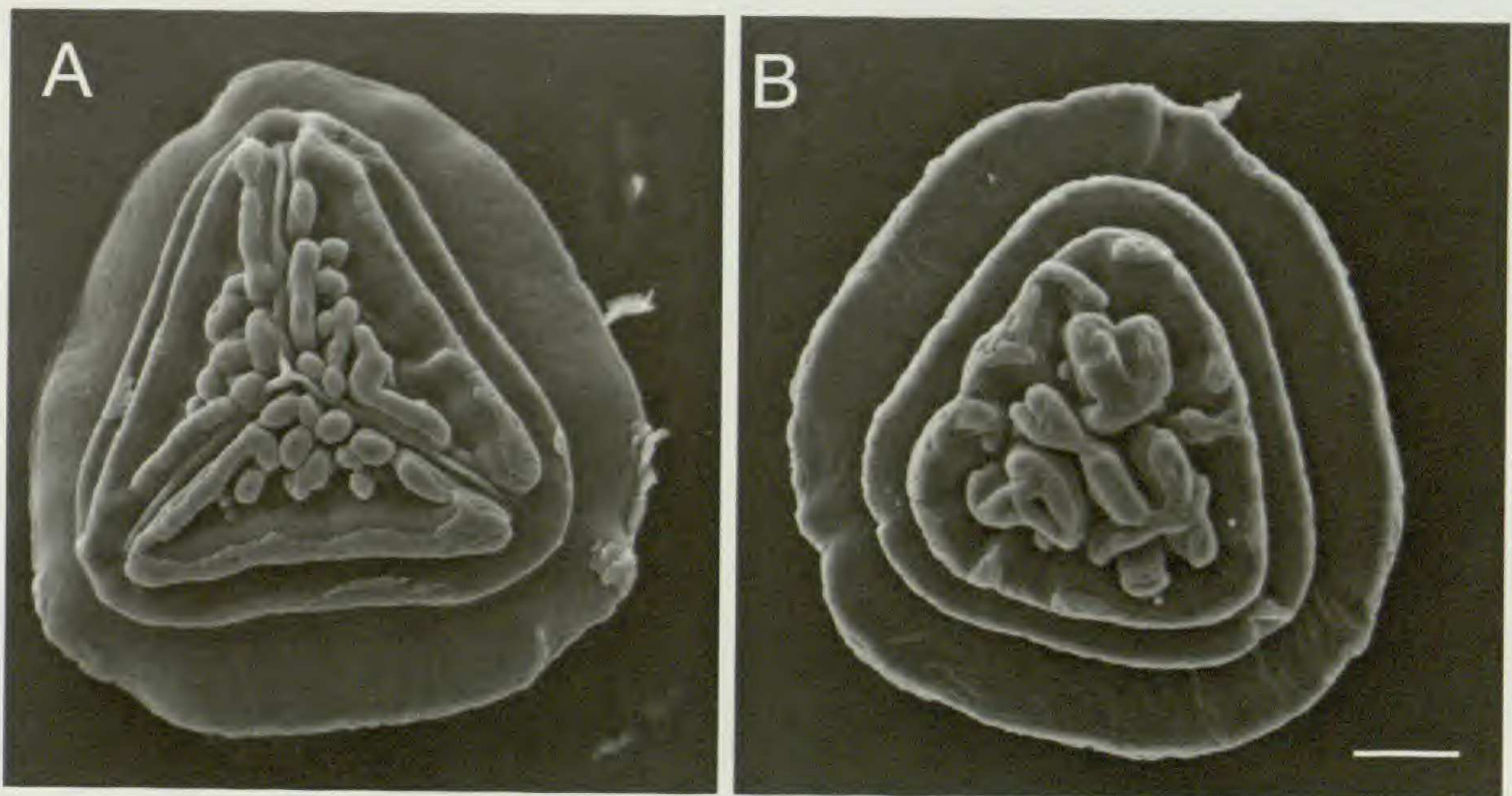


FIG. 3. Spores of *Pityrogramma opalescens* (based on the isotype, NY). Scale bar = 10  $\mu$ m. A. proximal face. B. distal face.

3.5–4.0 mm latis (vs. segmentis latoribus, 10.0–17.0 mm latis, in *P. lehmannii*), et farina sordido-aurea (vs. farina alba in *P. lehmannii*) differt.

Plants terrestrial; roots inserted radially, densely provided with golden-brown root hairs; rhizomes (Fig. 1A) 1.0–2.5 mm diam., radially symmetrical, short-creeping, light brown, sparsely scaly, the rhizome surface easily seen between scales, the scales (Fig. 1B) 0.5–1.2  $\times$  0.3–0.5 mm, basifixed, narrowly triangular, spreading, golden-brown, the cells somewhat turgid, lustrous, translucent, the margin entire, the apex acute; fronds erect, 35–65 cm long; petioles 20–35 cm long, 1.0–2.5 mm diam., with two vascular bundles, castaneous, lustrous, proximally and medially terete, distally with a shallow adaxial groove, essentially glabrous with a few scattered scales proximally, the scales similar to those of the rhizome, the petiole base provided with an epipetiolar bud, the buds bearing a tuft of scales and usually associated with 1–3 roots; rachises glabrous, abaxially prominent and similar to the petioles, adaxially the castaneous tissue of the rachis visible proximally, buried in the lamina tissue distally; laminae (Fig. 2A) 12–28  $\times$  (1)2.0–2.5 cm, linear, even sided, the base truncate, the apex attenuate, proximally 1-pinnate, distally 1-pinnatisect, with (30)60–70 pairs of segments, the segments (Fig. 2B) (5)10–12  $\times$  3.5–4.0 mm, narrowly triangular to nearly oblong, widest at the base, the base sessile, the apex narrowly rounded, the margins entire, the abaxial lamina surface (Figs. 2C, D) densely and evenly puberulent, the hairs ca. 0.1 mm long, light brown, erect, apparently secretory and the apices provided with a dull-yellow farina, the farina forming a confluent layer near the height of the sporangial capsules, the adaxial lamina surface (Fig. 2B) glabrous, striate, whitish on weathered leaves; veins free, forking, each lamina segment with 5–7 veins, these emerging directly from the rachis without a prominent costa or

main vein; sporangia spread along veins on the abaxial lamina surface; spores (Figs. 3A, B) 61–63  $\mu\text{m}$  wide, brown, frequently refracting light and reflecting blue and purple hues, trilete, with a broad and prominent equatorial flange, 10  $\mu\text{m}$  wide, that can be easily observed through the dissecting microscope at 60 $\times$  magnification.

ETYMOLOGY.—The name “opalescens” is derived from the iridescent mineral opal, which the spores of *Pityrogramma opalescens* resemble when they reflect light.

DISTRIBUTION.—Known only from the type collection made at 1700 m in very wet cloud forest on Cerro del Torrá, in Chocó, Colombia. This isolated mountain peak (summit 2770–2800 m) in the western cordillera (Cordillera Occidental) is one of four peaks in the Cordillera de San Miguel, which is separated from the Serranía de los Paraguas (a branch of the Cordillera Occidental) by a valley of about 600 m elevation (Silverstone-Sopkin and Ramos-Perez, 1995). It lies within the Chocó floristic region, one of the wettest and most species-rich areas in the world for plants (Gentry, 1986). Cerro del Torrá and the Serranía de los Paraguas are particularly rich in rare and narrowly restricted species (Silverstone-Sopkin and Graham 1986; Davidse and Clarke, 1996; Taylor, 1997; Struwe, 2003; Pedraza 2008).

With the description of *P. opalescens*, 11 species of *Pityrogramma* are recorded from Colombia (compiled from Tryon, 1962; Lellinger, 1977; Tryon and Stolze, 1990). Most of these are broadly distributed, but *P. opalescens*, and *P. dukei* Lellinger are both known only from Departamento Chocó.

MORPHOLOGY.—Spore morphology of *P. opalescens* (Figs. 3A, B) is similar to that of other species of *Pityrogramma*, as evidenced a broad equatorial flange, a second ridge that is parallel to it, and coarse markings on the face, which A. F. Tryon called “hieroglyphic marks” (Tryon and Lugardon, 1991). The equatorial flange in *P. opalescens*, however, is unparalleled in size, measuring 10  $\mu\text{m}$ , large enough to be seen through the dissecting microscope at 60 $\times$ . The spores of *P. opalescens* are also conspicuously iridescent, reflecting blue and purple hues when illuminated by a halogen bulb and observed with a dissecting microscope. Iridescence can be observed to a lesser degree in other species of *Pityrogramma* (e.g., *P. ebenea* (L.) Proctor) as well, and may also occur elsewhere in the family among genera with similar spores, but to my knowledge this has not been recorded in descriptive literature (Domin, 1928, 1929, 1941; Tryon, 1962; Tryon *et al.*, 1990). Iridescence has been documented from the megaspores of some species of *Selaginella*, where it is caused by colloidal crystal configuration of the exine in the spore wall (Hemsley *et al.*, 1994, 1998).

Epipetiolar buds of ferns are shoot initials that develop from the base of petiole. They develop into new stem tissue without a resting phase and without detaching from the primary plant body (Moran, 2004). These were termed epipetiolar rhizomes by Lellinger (2002). Wardlaw’s (1952) “detached meristems” differ from epipetiolar buds by being induced by damage to the

plant and by lacking a regular position. Bulbils, a type of asexual reproduction in ferns, also differ by generally detaching from the primary plant or becoming active after senescence of the leaf that bears them. The epipetiolar buds on *P. opalescens* appear as scaly protuberances at the base of the petioles. Roots can be seen emerging from most of these buds (Fig. 2A), suggesting that they are actively growing, not dormant. Epipetiolar buds are well documented from several families of ferns, including Hymenophyllaceae, Gleicheniaceae, and Dennstaedtiaceae (Bower, 1923; Troop and Mickel, 1968; Bierhorst 1969, 1974; Imaichi, 1980, 1985). To my knowledge, within the Pteridaceae they have been previously reported only from *Pteris wallichiana* J. Agardh (Chandra and Nayar, 1970). They are not mentioned within descriptions of the family in general taxonomic references for ferns (e.g., Tryon and Tryon, 1982; Tryon *et al.*, 1990).

DISCUSSION.—Despite being known from only a single gathering, the type collection of *P. opalescens* includes ample material, with all parts of the plant well represented in each duplicate. Photos of the isotypes were generously provided to me by Philip Silverstone-Sopkin (CUVC) before they were distributed. Based on my own searches and those conducted for me by colleagues, I do not believe that any other collections of *P. opalescens* reside in herbaria that harbor strong collections of Colombian ferns available to me at this time: CUCV, GH, MO, NY, UC, and US. The type locality of *P. opalescens* is remote and difficult to access. Consequently, I choose to describe the plant based on the material at hand in order to draw further attention to this remote, under-collected, and species-rich area.

The NY sheet of the type collection was originally distributed as "*Pityrogramma* sp." and most likely corresponds to the collection identified as such in the phytogeographic study of Cerro del Torrá conducted by Silverstone-Sopkin and Ramos-Pérez (1995). This species was probably not described until now because unlike most collections from the study, the duplicates of Ramos *et al.* 1523 were not widely distributed.

Superficially, *Pityrogramma opalescens* bears a strong resemblance to *Jamesonia verticalis* Kunze, so much so that the isotype at NY was previously misidentified as that species. The two share elongate even-sided laminae with short undivided segments and castaneous axes. Both species grow sympatrically at Cerro del Torrá. *Pityrogramma opalescens*, however, clearly does not belong to *Jamesonia* or the closely allied *Eriosorus* because *P. opalescens* has rhizomes with scales rather than bristles, veins that end before the lamina margins, and farina present on the abaxial lamina surface. By comparison, *Eriosorus* and *Jamesonia* have rhizome scales with bristles instead of scales, veins that end at the lamina margins, and non-farinose surfaces. *Jamesonia verticalis* itself can be further distinguished by its puberulent rachis.

*Pityrogramma opalescens* is probably most closely related to *P. lehmannii* (Hieron.) R. M. Tryon, an infrequently collected species known from 1200–2400 m, northern Ecuador and southern Colombia. The two share creeping rhizomes, with scales that have turgid cells, an elongate lamina, with sessile

undivided segments supplied by several veins that emerge from the rachis rather than from a single main vein, and farina on the abaxial side of the lamina that is borne at the apex of short hairs. *Pityrogramma lehmannii*, however, differs by having fewer segments (20–25) that are nearly as long as they are wide (12–17 × 10–17 mm), with more broadly rounded apices, and white rather than dull-yellow farina abaxially. Based on the material that I have seen, *Barclay 9463* (GH), *Lehmann 8944* (GH, isotype), *Madison 883* (GH), *P. lehmannii* does not have epipetiolar buds or iridescent spores. In other respects, however, the spores are similar and have a very wide equatorial flange like that of *P. opalescens* (Tryon and Tryon, 1982).

The characters that unite these two species and distinguish them from other species of *Pityrogramma* are unique within the genus. Other species of *Pityrogramma* generally have erect rhizomes with scales that have flat cells, deltate or lanceolate laminae that are more finely dissected, and stipitate segments that are served by a main vein. If they are farinose, the farina is sub-sessile on the abaxial lamina surface borne on surficial glands rather than clearly at the apex of short hairs (0.1mm long). When describing *P. lehmannii* (as *Gymnogramme lehmannii*), Hieronymus (1905) thought it distinct enough from its congeners in *Gymnogramme* to warrant a new section, *Isgnogramme*. Christensen maintained *P. lehmannii* in *Gymnogramme* when he adopted *Pityrogramma* in his 1934 supplement of *Index Filicum*. Tryon (1962) made the transfer into *Pityrogramma*, but noted the morphological discrepancy, as did Yatskievych *et al.* (1990).

These observations raise doubts as to the placement of both *P. opalescens* and *P. lehmannii* in *Pityrogramma*, but no alternate placement seems more appropriate. One possible alternate placement to consider for these plants is *Pterozonium*, but that would result in equal morphological discrepancy. *Pterozonium* is a morphologically diverse genus, and some species are similar to *P. opalescens* and *P. lehmannii* in having creeping rhizomes provided with scales that have turgid cells, lamina segments with rounded apices and that do not have a main vein, and farina on the abaxial lamina surface that is borne at the apex of short hairs. However, the stipitate segments, tuberculate or regulate spore surfaces that lack “hieroglyphic marks” (Tryon and Lugardon, 1991), and peculiar geography of *Pterozonium* argue against it as the correct home for *P. opalescens* and *P. lehmannii*. Consequently, they are maintained in *Pityrogramma* pending further study.

Given their unique suite of characters, *P. lehmannii* and *P. opalescens* should be prioritized in future phylogenetic studies aimed at unraveling the evolution of the taenitid ferns.

#### ACKNOWLEDGMENTS

I thank Philip Silverstone-Sopkin for generously providing photos of collections at CUVC and details about the geography of Cerro del Torrá. The type collection of *P. opalescens* was collected on an expedition financed by The National Geographic Society grant number 3884-88 to Silverstone-Sopkin. I also thank Alan R. Smith and George Yatskievych for lively conversations about *Pityrogramma* and the taenitid ferns. Two anonymous reviewers provided helpful comments. Priscilla Muriel provided locality data of *P. lehmannii* at QCA, Greg McKee checked

the collections at US, and Jefferson Prado and Gerald Gastony assisted with the Latin diagnosis. To them I am indebted. Portions of the work resulting in this manuscript were funded by NSF grant DEB 0717056 to Robbin Moran. The illustration in figure two was provided by H. Fukuda.

## LITERATURE CITED

- BIERHORST, D. W. 1969. On *Stromatopteris* and its ill-defined organs. Amer. J. Bot. 56:160–174.
- BIERHORST, D. W. 1974. Variable expression of the appendicular status of the megaphyll in extant ferns with particular reference to the Hymenophyllaceae. Ann. Miss. Bot. Gard. 61:408–426.
- BOWER, F. O. 1923. *The Ferns: (Filicales): treated comparatively with a view to their natural classification*, Vol. 1. Cambridge University Press.
- CHANDRA, S. and B. K. NAYAR. 1970. Some aspects of the morphology of the rhizome of *Pteris wallichiana*. Proc. Indian Acad. Sc. 71:79–85.
- CHRISTENSEN, C. 1934. *Index Filicum Supplementum Terium Pro Annis 1917–1933*. Hafniae apud H. Hagerup, Copenhagen.
- DAVIDSE, G. and L. G. CLARK. 1996. Two new species of *Neurolepis* (Poaceae: Bambuseae) from Colombia. Novon 6:150–156.
- DOMIN, K. 1928. Generis *Pityrogramma* (link) species ac sectiones in clavem analyticam dispositae. Spisy Přír. Fak. Karlovy Univ. 88:6.
- DOMIN, K. 1929. The hybrids and garden forms of the genus *Pityrogramma* (Link). Rozpr II. Tř. České Akademie 38:3–80.
- DOMIN, K. 1929b. Letter to Carl Christensen. February 2<sup>nd</sup> 1929. Archives of the Alice and Rolla Tryon Pteridophyte Library. Pringle Herbarium. The University of Vermont.
- DOMIN, K. 1941. Additamentum primum ad filicum Americae tropicae australis et mediae insularis cognitionem. Genus *Pityrogramma* (Link.) Dom. Věstn. České Společn. Nauk. Tř Mat.-Přír. [Mém. Soc. Sc. Bohême, Cl. Sci.]. 15:1–8.
- GENTRY, A. 1986. Species richness and floristic composition of Chocó region plant communities. Caldasia 15:71–91.
- HEMSLEY, A. R., M. E. COLLINSON, W. L. KOVACH, B. VINCENT and T. WILLIAMS. 1994. The role of self-assembly in biological systems: evidence from iridescent colloidal sporopollenin in *Selaginella* megaspore walls. Phil. Trans. Roy. Soc. London B. 345:163–173.
- HEMSLEY, A. R., B. VINCENT, M. COLLINSON and P. C. GRIFFITHS. 1998. Simulated self-assembly of spore exines. Ann. Bot. 82:105–109.
- HIERONYMUS, G. 1905. Plantae Lehmannianae, pteridophyta. Bot. Jahrb. Syst. 34:417–582.
- IMAICHI, R. 1980. Developmental studies on the leaf and the extra-axillary bud of *Histiopteris incisa*. Bot. Mag. Tokyo. 93:25–38.
- IMAICHI, R. 1985. On the extra-axillary buds of *Histiopteris* and *Hypolepis* collected in Bolivia. Bull. Fac. Agr., Tamagawa Univ. 25:23–33.
- LELLINGER, D. B. 1977. Nomenclatural and taxonomic notes of the pteridophytes of Costa Rica, Panama, and Colombia. Proc. Biol. Soc. Wash. 89:703–732.
- LELLINGER, D. B. 2002. A modern multilingual glossary for taxonomic pteridology. Pteridologia 3:1–263.
- MICKEL, J. T. and A. R. SMITH. 2004. The Pteridophytes of Mexico. Mem. New York Bot. Gard. 88:1–1054.
- MORAN, R. C. 2004. A Natural History of Ferns. Timber Press, Portland.
- NAKAZATO, T. and G. J. GASTONY. 2003. Molecular phylogenetics of *Anogramma* species and related genera (Pteridaceae: Taenitidoideae). Syst. Bot. 28:490–502.
- PEDRAZA, P. 2008. Three new species of *Disterigma* (Ericaceae: Vaccinieae) from western Colombia, with comments on morphological terminology. Brittonia 60:1–10.
- PICHI SERMOLLI, R. E. G. 1985. The fern genus *Cosetinia* Todaro. Webbia 39:179–189.
- PRADO, J., C. DEL NERO RODRIGUES, A. SALATINO and M. L. F. SALATINO. 2007. Phylogenetic Relationships among Pteridaceae, including Brazilian Species, Inferred from *rbcL* Sequences. Taxon. 56:355–368.



- SÁNCHEZ-BARACALDO, P. 2004a. Phylogenetic relationships of the subfamily Taenitidoideae, Pteridaceae. *Amer. Fern J.*, 94:126–142.
- SÁNCHEZ-BARACALDO, P. 2004b. Pylogenetics and biogeography of the neotropical fern genera *Jamesonia* and *Eriosorus* (Pteridaceae). *Amer. J. Bot.* 91:274–284.
- SCHUETTPELZ, E., H. SCHNEIDER, L. HUIET, M. D. WINDHAM and K. M. PRYER. 2007. A molecular phylogeny of the fern family Pteridaceae: assessing overall relationships and the affinities of previously unsampled genera. *Molecular Phylogenetics and Evolution* 44:1172–1185.
- SILVERSTONE-SOPKIN, P. A. and S. A. GRAHAM. 1986. Alzateaceae, a plant family new to Colombia. *Brittonia* 38:340–343.
- SILVERSTONE-SOPKIN, P. and J. E. RAMOS-PÉREZ. 1995. Floristic exploration and phytogeography of the Cerro del Torrá, Chocó, Colombia: 169–186 In *Biodiversity and Conservation of Neotropical Mountain Forests, Proceedings of a Symposium, New York Botanical Garden, 21–26 June 1993*, Churchill, S. P., Balslev, H., Forero, E. and Luteyn, J., eds, The New York Botanical Garden, New York.
- STRUWE, L. 2003. Two new winged species of *Symbolanthus* (Gentianaceae: Helieae) from Colombia. *Novon* 13:133–140.
- TAYLOR, C. M. 1997. New species of *Palicourea* and *Psychotria* (Rubiaceae: Psychotrieae) from northwestern Colombia. *Novon* 7:191–200.
- TROOP, J. E. and J. T. MICKEL. 1968. Petiolar shoots in the dennstaedtioid and related ferns. *Amer. Fern J.* 58:54–70.
- TRYON, A. F. and B. LUGARDON. 1991. *Spores of the Pteridophyta: surface, wall structure, and diversity based on electron microscope studies*. Springer-Verlag, New York.
- TRYON, R. 1962. Taxonomic fern notes. II. *Pityrogramma* (including *Trismeria*) and *Anogramma*. *Contr. Gray Herb.* 189:52–76.
- TRYON, R. M. and R. G. STOLZE. 1989. Pteridophyta of Peru, part II, 13. Pteridaceae–15. Dennstaedtiaceae. *Fieldiana, Bot.* 22:1–128.
- TRYON, R. M. and A. F. TRYON. 1982. *Ferns and Allied Plants with Special Reference to Tropical America*. Springer-Verlag, New York.
- TRYON, R. M., A. F. TRYON and K. U. KRAMER. 1990. *Pteridaceae*. In: *The Families and Genera of Vascular Plants. Vol. 1. Pteridophytes and Gymnosperms*. Kramer, K. U., Green P. S., eds, Springer-Verlag, Berlin, pp. 230–256.
- WARDLAW, C. W. 1952. *Morphogenesis in plants*. John Wiley and Sons, New York.
- YATSKIEVYCH, G., M. D. WINDHAM and E. WOLLENWEBE. 1990. A reconsideration of the genus *Pityrogramma* (Adiantaceae) in western North America. *Amer. Fern J.* 80:9–17.
- ZIMMER, B. 1991. Remarks on the Greek cheilanthoid ferns. *Botanika Chronika* 10:211–237.